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Abstract

This article connects to the present day awareness of educators at all levels that the methods for measurement and testing of knowledge have to be reconsidered and modernised. For it is not the definition of knowledge that has changed since the 1968 student revolution; what has changed is how it is valued. Moreover, the general opinion among educators is that knowledge is the result of the student's analytical ability. Therefore, the tasks of examination are mostly of the analytical kind. However, teaching strategies are very often adapted to project work and overviews of subject domains, which requires thinking in holistic terms. A consequence of these changes is that they presuppose testing for synthesis. Since synthesis implies that the student is sensible for structural clues, this kind of testing must unconditionally be based on the student's production of text. A study of concept understanding could show clear indication of an awareness of structure, but the kind of structure remained unknown. The presented approach for testing synthesis is based on Perspective Text Analysis (PTA), which is founded on the Agent-action-Objective paradigm. The demonstrated test results are an illustration of what kind of structure a particular synthesis is based on. In order to make an underlying structure manifest and the resulting synthesis knowable, it is, however, necessary to take specificity and uniqueness into account. Therefore, rules of performance, typical for intelligence tests are of minor import. Instead, it is the single student's perspective – his synthesis – that emerges out of the verbal flow in the produced text.

Background

About a generation ago, a revolution within the systems of higher education has taken place. The students of the 1968-movement required that their training should be based on “searching for wholeness”, which enforced a change in perspective. This change translated into a renewal of curricula and study plans towards floating subject borders as well as equal value concerning various forms of knowledge and examination. The concept of “knowledge approach” became fashionable and everyone, who had something to say in this respect, promoted exclusively the understanding of knowledge as collectivistic property. As a consequence of this view, knowledge was conceived as a property that could be managed by schools, colleges and universities. Thus, the teacher’s task was to overlook and direct group and project work, but not to evaluate or judge knowledge in the traditional sense or even to differentiate between performances. “Wholeness” has established itself as a concept that is applied on all levels of the educational system whenever preciseness in demand or requirements shall be circumvented. This means that the students avoid precise descriptions of the knowledge they want to gain and the teachers are escaping the definition of their competence requirements. In Sweden, the concept has been made the leading star of the new programs and study plans of the Gymnasium.

An observation of some interest is that the natural sciences were leading the reform movement. Today a new interest is appearing for the conceptualisation of education in terms of wholeness and still natural scientists are in the lead. Maybe, they have become aware that the linear constructions of their subject and knowledge exam have been the loser of the 1968-movement’s eagerness to change. Once in a while, proponents of the Councils of Research and Technology are stating that the natural science subjects are not attracting as many students as would be needed for development and growth. The underlying assumption seems to be that society has been successful in impressing on young people the idea that racking one’s brain, as would be required in the study of natural sciences and technical subjects, would have no life quality. Independent of how many group and project studies are incorporated into the courses, subjects like physics engineering, and computer knowledge remain linear and analytic. However, if the aim is to provide the students with a more holistic view of the world, one should try China’s way. At the Beijing University, the trend seems to be away from a streamlined educational system and towards a holistic perspective concerning the students’ choice of subjects. At the elite level they have the possibility to select courses from other disciplines than pure natural science and engineering and to add the collected credit points to the points needed for their exam (Yimin, 2001). Applying more holistic appearing forms of working and examination is, however, no solution to the problem of changing the low degree of recruiting. When everything has been taken into account, still the fact remains that some concepts and factual relationships within the natural sciences cannot be approached through discussion alone in the spirit of some democratic and collectivistic view of knowledge.

The trend in the USA is much like the trend in the rest of the Western world. The natural scientists are reconsidering their educational designs in order to make their subjects more attractive, e.g., through introductory courses (Stokstad, 2001). But what are they doing? Well, “action learning” is the new concept of fashion for all courses with the aim to make the subject domain understandable and interesting. This implies that presentations in lecture halls as means of communication already for the newcomers are substituted with courses that require laboratory work (Marvis, 2001). This kind of educational activity has become known as “student research” and “graduate research”, which has been asked for by the students, but is less favourable for the staff members, since the cost of time investment is higher than the output effect: “Faculty assess it as a very positive experience for the students but mixed for themselves” (Marvis, 2001, p. 1615).

This educational approach, however, is nothing new. One of the major figures in the field of action learning has been Max Wertheimer (1880-1943), who together with Wolfgang Köhler and Kurt Koffka founded the “Berlin School of Gestalt Psychology”. The same problems teachers had with its application during the 1920’s are reappearing today, namely to specify what kind of knowledge shall be gained (Gonzales, 2001). In Sweden, this concept has taken the form of an “Educational Academy” at the Lund Institute of Technology. Its goal is to provide teachers with the opportunity to demonstrate what their students are doing, but nothing is said about the teacher’s relation to his subject (Thorsson, 2001). What the student is expected to gain from all these activities is not in focus. But like in the beginning of the 70’s, it is the conditions set by the student, which are governing the process (see the discussion in I. Bierschenk, 1999b).

It is important to note that there is a difference between “learning by doing”, proposed by John Dewey (1859-1952) and “action learning”, founded on the principles of Gestalt psychology. That a holistic view of knowledge can be produced at the lower levels of an educational system is a misconception, since it is scantly possible to create wholeness before the particular parts of a subject have come into place. In addition, it is not the teacher but the student himself, who is creating wholeness. Furthermore, what is wholeness for one student may be parts for others. Therefore, it may be concluded that it is a misdirected belief that “project work” in the Swedish Gymnasium can provide the basis for bringing about a wholeness-effect by writing logbooks. The purpose with the latter is to make one believe that the students get an overview of how a research and learning process develops, but the effect appears to be contra productive. There is a risk that the anticipated process centres on a procedure with minimal or no learning effects. Further, no clear understanding has emerged on the kind of text a student is expected to produce, or if the end product should be in written form at all. Moreover, if the students are required to produce an essayistic or popular science style, one may doubt if the responsible authority knows what it is demanding. The ability to synthesise, which would be required, is far beyond and possibly achievable by humanists only (Proctor, 2003).

That the natural science subjects have difficulties with the creating of synthesis and consequently testing of synthesis will now be demonstrated with an example from the USA. The physicist and mathematician David Hestenes has developed a multiple-choice test with the purpose to study the understanding of Newton’s mechanics. The test has been called “Force Concept Inventory” (FCI) and consists of 29 items. Hestenes could show that even the brightest students did not grasp the important concepts after they had been presented in the form of lectures. Their understanding increased with about 10% after teaching with the “active learning” method (Stokstad, 2001). However, this method cannot produce synthesis. It is not enough to generate an understanding of concepts. The test has possibly the capacity to give some indications about analytical thinking, but with synthesis it is meant how one in a constructive way can apply acquired insight. Expressing one’s synthesis would have required that the students are applying the tested concepts transformative, i.e., in the form of a discourse (see Bang & Elstrup Rasmussen, 2000). This example is a clear demonstration of the kind of understanding that is missing in the natural sciences. Working with lab-assignments and with investigations is a way of facilitating learning for different kinds of students, as in the case of “active learning”, but it does not mean that the cooperative integration of subjects in the form of projects, which is aiming at a holistic view on education, is providing any greater insight into any one of the participating subjects of study. The lower the level is on which this method is applied the higher is the risk that the effect is a shattered view of the world.

The philosophy behind the design of courses, exam and judgement of performances is an important part against the background of the selection, which must be made for entering the study courses at higher levels. The medical schools, for example, have always been tied to extremely high credit courses as basis for selection of students coming from a Swedish Gymnasium. Traditionally, analytical thinking has been rated as superior since it is the foundation for those credit points that result in the highest admission ratings. However, some medical schools have supplemented their admission exam with interviews but still there is a great risk that highly motivated students remain outside. Motivation and interest seems to have greater predictive value for the way in which studies develop compared to the results from knowledge tests. Grades and various admission tests seem to be insignificant after the students have entered their programs. Some studies, carried out in Germany, have shown that less than 10% of the ability to study and to be successful in the case of medical students can be accounted for by medical grades. This information can be found in Abel (2000, p. 9).

In the present context, interest should be understood as “fundamental life interest”, which gets its concrete expression through the goals one strives for, e.g., education, family, life style and conduct. In a study of persons, who recently had become parents, their judgement of risky situations for their infants was investigated. As background factor, their indicated interests were used in the interpretation of their written responses (Bierschenk & Bierschenk, 1993). The study showed that interest was governing the parents’ perception of the given situation as well as their judgement of the involved risk. For these parents the judgement of risk in a given situation is an acute question. A misjudgement may have serious consequences for the child.

An educational situation can be conceptualised in the same way. For the student, it is of greatest import that the information, given in a study situation or at an exam occasion is correctly judged. Otherwise, it may have negative consequences for further planning of one’s life. Risk taking is also involved in strategic choices of study courses, since it is one’s interest, which in the end is decisive for success in study. Abel (2000) presents a critical study of the Gymnasium in Germany and concludes that the choice of courses and orientation in study in the first hand seems to be made on the basis of personal interests. One explanation among others is that the students of today have other plans with their education at a Gymnasium than to continue with studies at the schools of higher education. A multitude of other possibilities are competing with going to a university in order to materialise one’s goals of life. Further, Abel notes that the results of study and gained grades are, moreover, dependent on the interest of the student for a particular subject. He mainly criticises the Gymnasium for the strictures that it is passing on the possibilities of choice, since they are constraining success in study (measured in grades) and thus optimality in achievement for the single student.

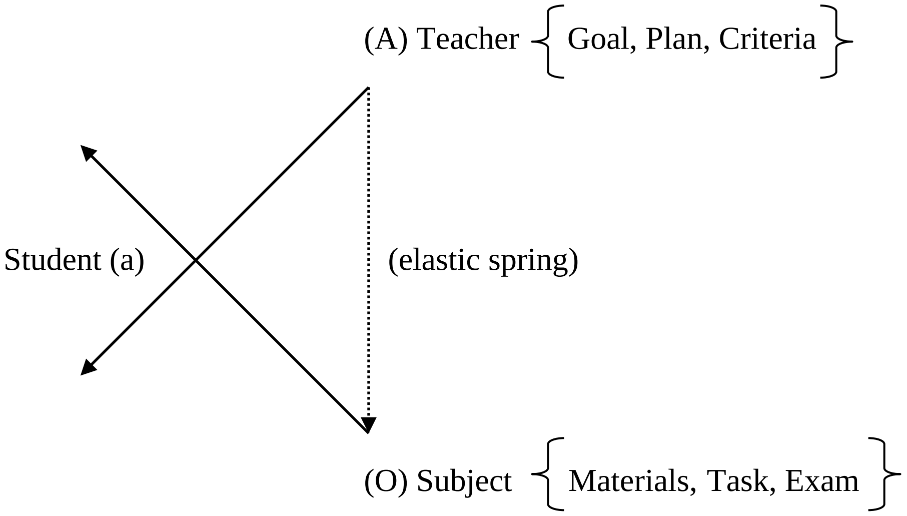
But it is a mistaken belief if one expects that the teacher’s task is to try to improve the results of study and arouse interest through various activities, which make the lessons easy and learning entertaining. On the contrary, building up an interest in a subject is a serious enterprise. The natural science departments, such as the Technical Institutes in Sweden, are organising “research days” for students at various ages, thereby hoping to improve the number of admissions. The same applies to the humanistic departments. They organise “humanist days” and corresponding thematic activities. However, it is very difficult to bypass the impression that this kind of initiatives ends up in entertainment. In contrast, in England there have been made serious attempts with scientifically based teaching in middle schools. It could be shown that the participating students had improved considerably when measured with cognitive scales as well as on tests of the mother tongue (Waksman, 1999). The explanation of these results can be found in the fact that the teachers were experienced scientists and often seniors, who became engaged in the education of the children. Since children are very sensitive to genuine knowledge, they become attracted to a subject when they are experiencing that its representative can provide them with the cognitive skills that are necessary to grasp the coherence and to get an overview. It is only natural that the interest thus created is spreading to other subjects and disciplines. Other comparative experiences have been made during the 1960's but at other levels of the school system (Epstein, 1970). Experienced scientists are basing their teaching on structuring and disciplining of their subject. And this is of course the goal of schooling. The following discussion will be concentrated on some conditions for how this goal can be realised.

An Elastic Teaching Device

Against the background of the preceding discussion, it can be stated that synthesis is the goal of teaching. What synthesis-based teaching means will be clarified on the basis of the Clip-model, which is based on the Agent-action-Objective (AaO) paradigm (B. Bierschenk, 1984). Transformed into a student-clip, Figure 1 presents the dependency relations.

Figure 1.

The Student Clip



The notion "clip" has been assigned to the Figure in order to highlight that the student in a teaching situation has always been situated in a clip at all times. However, what kind of effect it may have depends on the elasticity in the operations of the other components.

The student (a) represents the action component of the AaO paradigm. His ability to carry out work and to be successful in his enterprise is of course dependent on his teacher's ability to govern the involved process on the basis of a plan. This means that the teacher has a clear understanding of his goals and of the criteria for the judgement of the student's performances. To clarify criteria means to approach a teaching situation in an instrumental spirit. Criteria need to be made operational and require their expression through items, which relate to the expected terminal behaviour of the student. In this process the teacher is asked to adapt his tasks to a particular situation and to select appropriate materials and to construct a fitting test. However, independent of the teacher's ability and developed style of teaching, it is important to observe the operation of the clip. This means that a teacher must pay attention to its elasticity. The clip should guarantee that the student becomes successful in his attempt to complete the task.

The teacher (A) has the task to develop a student's ability to synthesis. In what way the relation in the clip develops, depends on the way in which the teacher is relating himself to his subject. It follows that the dynamic of the clip become an unconditional expression of the teacher's assignment of the students' workload.

The subject (O) is immediately bound to the tension, which is produced by the workload. Is the elastic A-O dependency lost, the student is falling off in his understanding of what is expected from him. Thematic cooperation between various subjects can easily lead to loosing ties, which implies that the students are left alone. On the other hand strain tension in the spring is produced when cram exam are squeezing the student too much. The effect has the assignment of having a reading load of e.g., novels in literature, and language studies. The latter means that too much weight is applied on the O-component. A properly charged elastic spring in the clip is the only way to promote the development of one's ability of synthesising.

It is generally known that the tests and examinations in school and university aim at the manifestation of various terminal behaviours as expression of a reached goal. But it has also been shown that the conventional types in its major part are manifesting memory knowledge (about 70%). Understanding on the other hand accounts for at most (15%), while the student's analytical capacity takes (12%) into account. Only (3%) can be associated with synthesis (Frederiksen, 1984). As will be demonstrated later, a new kind of research makes evident that teaching without explicit goals for synthesis cannot establish proper functional performances neither in verbal nor written form.

The starting point of a synthesis creating process must be bound to the O-component, since the subject is manifesting itself through text production. The text of a task instruction, a study material and an exam is in itself an expression of synthesis, which must be comprehended, transformed and reformulated. In the following, some examples will be provided as a background for a discussion of the conditions for measurement and testing of a student's ability to gain from teaching.

A Comparison between Linear and Criterion Related Examination

All kinds of teaching should aim at generating possibilities for the student to perform in order to get his best possible results as evidence for a realised learning process. Making the goals precise simultaneously with advising the student how to enter the learning path means basically to state the required quality of performance. Criteria for grading have been provided for all educational levels but they are not always very explicit in their formulation. Therefore, the student has generally difficulties to comprehend their meaning for his goal-oriented work.

Every task of learning module has its own specific criteria for performance and judgement, which implies that the criteria must be adapted to every single task. It follows that the criteria for one writing section may be irrelevant for another. Likewise, a module of a course in literature may be tested with an analytic-descriptive style of approach to manifest understanding and insight. Another kind of exam may have been constructed to make synthesis evident. The latter kind requires a reflective style and should not be mixed up with understanding (B. Bierschenk, 1994). In a context where different grade levels are of relevance the teacher has the obligation to formulate a test item or other inquiry, which guarantee that each and every one is properly judged.

At present two principles are competing, namely the linear and the absolute or criterion related. When the linear principle is applied the lower grade levels are included in the higher knowledge levels. This means that the formulation of the task is passing from the lower to the higher, i.e., solving an easy task is a prerequisite for advancing to a more difficult one within one and the same type of task. Hence, a manifestation of this type of task may require the description of a phenomenon and at the next higher level its analysis and interpretation. The latter implies that the teacher must be able to discriminate and extract the levelled answer from the same question. In this situation the teacher is comparing one criterion with the other and so the procedure becomes bound to frequency counts concerning the reached level of performance. Hence, the teacher's judgement becomes relative and the student is exposed to the teacher's subjective apprehension. It appears very likely that the teacher is judging a general ability instead of the task-oriented, because the latter cannot be penetrated. In-transparency is very often a source for the student's uncertainty and frustration, since the outcome has many a priory given factors.

When the absolute or criterion related principle is governing task construction, the task is exclusively formulated. The measurement scale is not continuous and the two levels exclude each other. Each task formulation has its own specific formulation. Under this condition the teacher is making explicit that the student makes his own judgement of his knowledge within a given module. It is the student's judgement that defines the level of the exam. After careful analysis of the conditions and requirements the student is choosing the level on which he wants to be tested, aware of the consequence that the answer cannot be judged on another level (lower or higher) than what the task is specifying. In the case the aspired level has not been passed the student has failed on the entire exam. (If one knocks the bar off at 2.10, the bar is not placed at 2.00 in the same jump. One has to make a new attempt.) But the absolute principle has also some disadvantages. By reading the task formulation, the student must be able to apprehend what is required for a satisfactory answer to the given question. This implies the ability to analysis and synthesis as well as good self-knowledge.

A module of the study course of Swedish (A) at the entrance level of the Swedish Gymnasium deals with old time literature. The result of two styles of examination will now be compared: writing tasks concerning prehistoric and classical myths, and the middle ages respectively. The tasks were given to the students that had enrolled in the following programs: Fine Arts (FA), Business Administration (BA) and Natural Sciences (NS). The first examination task was designed in a linear and inclusive fashion. The other had the form of an absolute and exclusive test. Table 1 shows that a number of students had been successful in increasing their levels of performance through the criterion related exam compared to the linear construction. Only one student had not passed, because he misunderstood the theme of the second occasion. He was only very infrequently participating in lesson hours.

Table 1.

Comparison between the Students' Results on Linear and Criterion Related Tests

	Linear, Inclusive Principle				Criterion Related, Exclusive (absolute) Principle			
Grade[1]	IG	G	VG	(N)	IG	G	VG	(N)
FA	2	15	6	23	0	11	8	19
BA	1	14	13	28	1	6	22	29
NS	0	7	23	30	0	8	21	29
(N)	3	36	42	81	1	25	51	77
%	4	44	52	100	1	32	66	100

[1] Note: The letter combinations refer to the presently applied system, which is explained in the text below.

The proportion of student that passed the exam (G) diminished from (44%) on the first type of test to (32%) on the other type (N=81), while the portion of well passed (VG) increased from (52%) to (66%). Both the students from the Business Administration program and the program of Fine Arts improved the outcome of their working compared to the traditional way and increased their proportion of (VG) on the second type. With respect to the students from the Natural Science program, the results make no difference when related to the type of exam. Quite a few students from BA tried their luck and were successful. On the other hand, the students from NS are normally performing on the VG-level, but did not try. Maybe, this result indicates that some NS-students have deficiencies concerning their ability to read out what the question formulation is asking for. One interpretation of this result is that these students are uncertain about their synthesising ability. The other is, that they have become aware that the normally applied analytical skills are insufficient for producing the right solution to the stated problem.

An Exam with Different Degrees of Difficulty

This section is devoted to another exam, however, now a more difficult course (B) of Swedish. The exam was aimed at the demonstration of the students' knowledge of the 18th century literature and the condition were about the same as for the criterion related exam of the middle ages in Swedish (A): Going through corresponding text sections and history of literature during lesson hours. In the exam, the students were asked to produce a text in order to answer for them unknown essay questions. As an aid the entire class was provided with typical questions for this kind of exam, to which the class had access before the exam. Their formulation made clear what was expected in order to pass one or the other degree of difficulty: passed, well passed, and very well passed. Moreover, the students were allowed to have their text anthology as well as their notes with them. The students also knew that the exam would be of the inclusive type, i.e., if they had aspirations on a higher level than they would manage to pass, still they would get a lower degree, which however not automatically led to (IG) "not passed".

In contrast to the preceding section, this time the focus will be on how the students in the three programs made their choices and passed the exam. Table 2 demonstrates the outcome.

Table 2.

A Comparison between Aspiration and the Realised Levels

	Aspiration				Realisation				
Degree[1]	IG	G	VG	MVG	IG	G	VG	MVG	(N)
FA	0	6	9	4	0	9	9	1	19
BA	0	0	16	10	2	10	13	1	26
NS	0	0	18	9	1	12	14	1	28

[1] Note: The letter combinations refer to the presently applied system, which is explained in the text above and additionally below.

One clear result concerns the students from the Fine Arts program. Their conception of their ability and what they perform in reality appears to be more in correspondence with each other compared to the other students. The nine students, who aspired to perform at the VG-level, did so. Those students who did not choose a higher level than (G), are usually doing no better. Moreover, the students from the BA and NS programs are very much alike in their choice behaviour. They believed that they would pass at a higher level than what would be realistic. (50%) (N=27) tried at the very well passed (MVG) level, but only two students from the corresponding programs performed at this level of difficulty. Furthermore, the students, who thus far never had reached the highest degree at any other occasion, did nevertheless try for the highest degree. An explanation for this kind of choice behaviour may be that they took the chance, because missing the degree would not automatically lead to (IG). There is no harm in trying! Several students would have passed at the VG-level, if they had tried. However, the formulation of the MVG-question requires another kind of understanding, which resulted in the grades (G) or (IG), since the students could not show that they had understood the question.

In summing up, it can be concluded that judging one's ability in a particular context is sometimes connected with misjudgement, which may result in over- or underestimation. The discussed results are supported by other studies. As a rule, high performers are underestimating their capacity with one step and low performers are overestimating their ability with two steps at a scale with five degrees (B. Bierschenk, 1992). The teacher's task is to guide the student in a way that he gets correct insight concerning his ability and to steer the teaching process towards the underestimating student's possibility to increase his certainty, while the overestimating student should not need to fail all too often. An advantage of the principle of absolute judgement is that it allows the student to take a chance and become surprised of his own ability. This principle gives way for the demonstration of qualitative leaps in one's development. The linear principle, on the other hand, cannot support this kind of process. But the educational question for the teacher is how to guide the student from an analytic to a synthetic level of performance.

Testing Conceptual Understanding

Teaching the central concepts of a subject has been a long-standing matter of discussion, formulation of goals, testing of teaching materials and concept understanding. In teaching physics, it is a question of getting the student familiar with concepts like resistance, power, and light. Conventionally, these concepts are communicated in the context of laboratory work, where the student is asked to make observations in order to discover the effects of the operations in an application. Understanding is thereafter measured on the basis of test items, which are constructed with the purpose to clarify the grasping of these concepts. But the student may also be confronted with a definition as stimulus for identification and naming of the concept as a response. This kind of approach was initially illustrated with David Hestenes' test construction.

Meanwhile, the conditions for conceptual understanding are not the same when a teacher presents his explanations on a theoretic and analytical basis compared to his attempt to bring about a deeper understanding (synthesis) of how a concept has been transformed and made functional, e.g., by means of narrative of power as it appears in the physical environment or in the context of human relations. This transformational process is changing the linearity of the concept, which means that the space of the concept comes into existence. To grasp a transformed concept, therefore, requires another kind of ability than would be required when the student is asked to match the labelled concept with its appearance in a verbal context. Bang and Elstrup Rasmussen (2000), for example, have studied how the concept resistance is developing when two female students are discussing with each other. The authors could demonstrate that, depending on one's personal preconditions, each student had her own learning strategy. One was oriented towards acquiring knowledge, while the other demonstrated a social conduct to the subject and the task as well.

All students do not perform in the same way in all types of tests. Furthermore, it is also important to keep in mind that learning is not developing in a linear fashion. Promoting a deeper understanding, which requires other abilities than pure cramming, would be preferable from a democratic point of view. For example, if a particular module in a course has been designed to facilitate the understanding of a concept when transformed into a narrative, then the teacher should realise that intuitive ability and insight into the narrative form of communication of a concept is something that not necessarily requires analysis but can be grasped on the basis of other experiences than are mediated in school. Thus, something else than pure memory would be requested. Intuition is something that the individual has gained through his development of knowledge, which constitutes the basis of emerging invariance. Invariance cannot be fragmented into pieces (by analysis) but is applied directly and in novel situations, which requires an immediate reaction. At least in the context of adults this ability to direct and adequate reaction is equated with competence.

In an educational situation, it is assumed that the teacher can be helpful in the student's attempts to build up knowledge. Furthermore, the teacher is expected to provide possibilities for making different kinds of experiences, which can make up the ground for the establishment of invariance. In connection with a student's study of literature the teacher has the task of identifying those properties of the study object, e.g., an idea or an abstraction, with the purpose to make their relationship with the surrounding society transparent. For example, functionalism and its relations to the art of social engineering and other forms of design may be demonstrative. But in what way can this kind of abstraction be transformed into a novel? Even though the teacher has been successful in drawing the line between different ideas and abstractions, still he cannot know how clear the understanding is. Further, it is quite impossible to know something about the way in which the learning and knowledge generating process has worked in the student's generation of invariants. On the other hand, the teacher has the possibility to control the means and materials, which the student is working with during lesson hours.

An example of teaching and examination of concept understanding on non-analytical grounds is provided in a study carried out during the spring term of 1997 (I. Bierschenk, 1997, 1998). A module was designed for teaching the students of Fine Arts, Natural Sciences and Social Sciences in the understanding of "ism" in literature and Arts (e.g., futurism, expressionism, surrealism) and their relationship to the scientific concepts of behaviourism, structuralism and functionalism, which are of relevance for the study of social relations, psychology and physical conditions. Over a number of weeks, the task of the students was to observe how these concepts and ideas had been transformed into societal models in literary form (novels). The resulting process generated a selective number of concepts, which relate to the literary texts and the authors. The design of the study is carefully described in I. Bierschenk (1997) and provides a preliminary study concerning planning of the teaching process as well as testing of concept understanding.

With the purpose of testing the student's concept understanding, a number of narratives were produced. Each narrative describes one concept in the form of a discourse. Hence this kind of item construction provides each concept with a context. If the exam had been carried out according to the conditions of Hestenes' test, the students would have to analyse each text and come up with the right ism as the correct response. If so, they would have been lured into an analytic and linear mode of thinking. Instead, the task to be solved was to relate the correct authorship of the text, which represented the concept, transformed into a discourse. This is a greater qualitative leap, compared to pure matching and was expected to encourage intuition and consequently transformative thinking which had been built up during the teaching period. An example of this kind of test item is the following narrative:

Item: Concept Transformation

Let’s go back to the ages of Renaissance and mirror us in that what Machiavelli said about the conditions of man. Some phenomena are everlasting, both in reality and literature. He mediates his opinion to the modern world through quite a few modern authors:

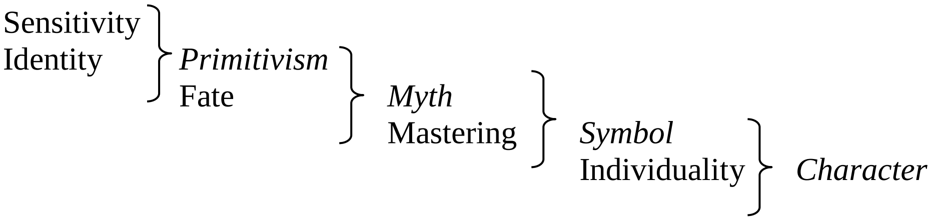
“I think the nearest way to reach Paradise should be to get to know the way to Hell with the purpose to avoid it. “

The experiment showed that this kind of test was difficult, which means that the time allotted to this teaching period (10 weeks) was not enough for building up the necessary invariants. But from the democratic point of view, the test demonstrated that the students, who normally stand out as superior (Natural Science students) did not better than the others. The students from the other programs were also alike in their performances (I. Bierschenk, 1997, Tab. 4). A reason may be that the testing did not build on the usual application of analysis and memory capacities but on the ability to transformation (i.e. synthesis).

Independent of the program, sameness in the students’ performances, did provide a further result, which has consequences for teaching. When the concepts were compared against the background of their degree of difficulty, clear differences in their levels could be demonstrated. Therefore, the main result of this study could be transformed into an evolutionary scale of four degrees. The increase in conceptual difficulty can be described with the following path:

Figure 2.

Path of Conceptual Understanding



The described path to understanding implies qualitative leaps. The primary and most basic condition for understanding literary text is building on the feelings of the reader, i.e., reading is arousing emotions. To take a first step on the path implies the provision of various kinds of text that can generate identity, which means that the reader can make comparisons with fictive persons in order to get an “I” understanding. In passing through the state of Identity the transformative result is emerging in the first conceptual level, namely *Primitivism*. At this level the student’s reading of literature is immature, nevertheless there is an adoption of simple connections, which may provide a basis for the next step to be taken. As the path indicates, the conditions to be fulfilled relate to the text, which concern various kind of Fate. At this state of reading, the student is expected to learn about fantastic stories and how fate is waving its web of strings from various times and cultures. The conditions, represented by this state relate to the author’s richness in words and ability to romance in a way that the reader not always can discriminate between reality and the lens of fiction. A student, able to make the distinction has transformed his conceptual thinking and created a relation to the concept of *Myth*.

Mastering mythical and broad epical novels provides for new insights, which can be tested and drive the development towards a deeper understanding of literature. Thus, the next step to be taken must include abstract phenomena, e.g. the technique of telling stories and the style of narration. The author's conduct to a subject, e.g., a cynic's functionalistic approach to mastering anxiety comes into focus. A reader, who becomes able to apprehend those kinds of dimensions of a text, has reached the operational level of *Symbol*. The deepest degree of understanding implies the step from analysis to synthesis. The latter requires the reader to extract complex structures and to apprehend their textual formation (i.e., embodiment). Texts on this level concern various steps of moral development and maturity as a property of individuals as well as civilisations. Therefore, it can be stated that literacy at the highest level has the power of creating *Character*. Likewise, as teacher, one would gladly assert that reading this kind of work is character forming.

The grouping of the 20th century literature on the basis of this scale results in the following levels:

Level 1: Behaviourism, Surrealism
Existentialism, Futurism, Provincialism, Psychoanalysis
Level 2: Magical Realism, Romantics, Social Realism
Level 3: Functionalism, Time
Level 4: Structuralism, Expressionism, Gestalt-Theory, Middle Class Idealism, War

In sum, the empirically derived scale has self-evident consequences for teaching. A discussion of the choice of a material with behaviouristic properties can be found in I. Bierschenk (1999c). The students' reaction as basis for a discussion of the conceptual structure of a futuristic novel has been presented in I. Bierschenk (2000a). Level 2 implies a transition from easier texts to texts with a higher degree of difficulty and does not take into account any distinct ism or comparative idea. Furthermore it turned out quite correctly that magical realism is founded on abstract motifs, which for the students are difficult to connect to societal development. Being able to generate this kind of relationship has been the aim with the teaching. It appears as if magical realism belongs more to developmental psychology than to fantasy, which only slightly corresponds with the genre.

The functionalistic idea, transformed into literature, has been discussed and in the analysis of style, a distinction has been made between this concept and behaviourism (I. Bierschenk, 2000c, 2001a). In a study of how a student can demonstrate, that his competence to digest a novel has deepened, compared to the action level, a novel with an expressionistic style of writing has been used (I. Bierschenk 2000b).

A conclusion of highest degree of relevance for teaching can now be drawn, namely that a novel cannot be assigned to any kind of student at any time. Furthermore, it is important to highlight that literary texts can be read at various levels of depth and at various occasions. In order to circumvent a situation, where the student becomes squeezed, a control of the material's conceptual depth could be a means for the teacher to steer the learning process in the right direction. The same applies to a control of the student's state concerning his depth of conceptual understanding. Even though the teacher would like to get all students in a class to read the same novel, this would not mean that task assignments must be one and the same for each and every student. Knowledge about the level of the material and the transformation of this level into corresponding tasks becomes a means to govern the development of the learning process. This way of perspectivation facilitates the elasticity of the process, since a conscious choice of materials gives steadiness to the teaching that cannot be achieved on the text quantity only. A study with this kind of conditions will be described in the following section.

Synthesis as Foundation of Examination

To begin with a situation, which implies that a student has a particular ability, but cannot demonstrate it on the basis of given test items, the teacher has difficulties in making a correct judgement or in setting the correct degree. This situation may develop in the suggestion of an exam of diagnostic character in order to decide, if the student at a certain point in time nevertheless is able to perform on the correct level of the given subject. In a subject like Swedish, the teacher can carry out an exam, which measures the student's competence or ability to synthesise without the need for testing various skills or qualifications. As previously discussed, it is reasonable to assume that a person may have developed an intuitive ability to perform properly without taking a detour road over a number of analytical steps. The ability to express an invariant structure at a certain point in time is conceived of to be valid for comparable tasks at other occasions. However, in demonstrating this kind of response behaviour, the student is required to produce a discourse. Demonstrating one's deeper understanding of the basic idea of a novel and to explain it in the form of free text production would be an appropriate task assignment for this kind of examination.

In the construction of the items for conceptual understanding, Machiavelli's maxim provided the basis for the definition of War. The empirical studies had shown that the concept of War belonged to structuralism, which culturally is bound to expressionism. The results made clear that it is a difficult concept to be grasped in its transformed form and, therefore, became empirically part of the forth level. The depth of the concept is sufficiently differentiated, which means that the student would be able to demonstrate on which level of reading he is digesting the given text. The highly concentrated formulation of Machiavelli may be understood as the quintessence of the concept. Understanding of the concept should be possible to be examined on the basis of a war-novel. The teacher's task is now to determine what kind of structure shall be understood and how understanding shall be tested. The idea of war, how is it emerging structurally?

Analysis by Synthesis

Compared to conventional text analysis methods, a new very different kind has been developed, which has the capacity to extract the structural relations in a text. This relationship cannot be analysed by reading from the textual surface only. The method is called Perspective Text Analysis (PTA) and has been developed during the last three decades. Its development has been described in a great number of publications, both from a theoretical and an applied point of view (e.g. B. Bierschenk, 1991, 1997, 2001; Bierschenk & Bierschenk, 1993, 2003a, 2003b, 2003c; Bierschenk, Bierschenk & Helmersson, 1996; I. Bierschenk, 1999a). The method builds on the discovery that language production independent of its content brings about rotations of graphemes and strings of graphemes, which unfold themselves into a space. The information structure in a text is accessible by means of an algorithmic working device and through topological descriptions. The latter have been made manifest in the form of holotops and holophors. Especially the holophor is the result of textual wholeness and makes explicit the shape of a mental landscape as it appears through a writer's orientation concerning a subject at a certain occasion.

As a first measure, the maxim about war can be analysed with this method in order to provide the key for the teacher's formulation of a test item and judgement. The landscape resulting from the maxim can thereafter be compared with the landscape of the text, which the student has produced after reading the assigned novel. If a student is able to produce his synthesis in the form of a comprehensive and interconnected text, then its structure becomes synonymous with the expected one and the student has passed the exam. Furthermore, the teacher has found an instrument for measuring the desired ability without squeezing the student, i.e., overloading him with more reading than absolutely necessary.

A student, who did not pass Swedish as subject course (A) at the Gymnasium chose to read a war-novel from the 20th century as his preparation for an new examination. The teacher applied PTA on the definition of war, which resulted in the structure, manifested in Figure 3, while Figure 4 shows the landscape of the examination text. The landscape of Figure 3 is very consistent and shows an aesthetic curvature with a top and some minor hill-formations together with a few soft slopes. This billowing shape points towards a text, which is very well balanced despite its minimal extension. The Figure (3) may be surveyed from the right to the left. The right hand side is marked with termini, which carry the structural invariants making up the theme of war. That *Riskiness* dominates the foothills appears meaningful from an ecological point of view. Moving in this kind of environment is associated with an awareness that one possibly does not survive. This path develops little by little into the singularity at the highest level of the mountain. The terminus at this point marks *Immediate Danger for Life*. The singularity of the minor top at the left hand side of the mountain is described with *Direct Action*. This implies the ability for proper reactions. The immediate danger for life presupposes that one is *Keenly Accurate in Response*, which in the present context implies a deepening of the embedded terminus. In its neighbourhood an attractor is emerging, which carries the terminus *Harsh Progression*. Thus, below sea level attractors are emerging, which imply a challenging movement towards the impending danger.

In sum, the entire structure appears to encircle one's ability to master a particular situation. Hence, to overcome or master a dangerous situation would be a proper description, which is matching the basic idea of the material. Furthermore, this notion is in perfect agreement with the evolutionary scale, where the forth degree of difficulty should lead to the deepest degree of understanding (mastery). The details of this study have been presented in I. Bierschenk (2000b).

The analysis of the student's text is presented in Figure 4. The handwriting of the student amounts to about one third of an A4 page. Thus, the text is much longer, compared to the control text. As a consequence, the student's text requires a greater space. Despite this difference, both spaces show landscapes with corresponding shapes: foothills in the foreground of the right hand side and a few peaks in the middle and the background. The foreground is characterised by a relatively even domain and at some places one can observe singularities below sea level, which indicate depth. But the landscape of Figure 4 has not the same gentle contour and harmonic formation. The mountains are tapering and sharp precisely like a younger mountain chain, compared to a geologically older formation. It follows that the transitions from one to the other are rough. This much younger and immature mental landscape is representing itself with a terminological structure that corresponds with the shape, when compared with the older landscape.

Riskiness has its correspondence in *Mastering*, while the highest mountain peak Impending Danger for Life here carries the terminus *Moving on the Crater Path*. Furthermore, Direct Action has its counter part in the sharper rising peak, which carries the terminus *Mutability*. That part of the shape, which is emerging below sea level, has the following correspondence: *Viciousness* has its equivalent terminus in Harsh Progression, which however shows a diagonal relationship, whereas *Sarcasm* is roughly counter balancing Keenly Accurate in Response in the older landscape.

The extent to which the formal analytical comparison between the terminological configurations can be shown to have its structural counter parts, is the decisive question. Therefore, Figure 5 has been designed in order to give a concise summary of the comparison between the older and younger landscapes in their dimensions of Height and Depth.

Figure 3.

Control Text

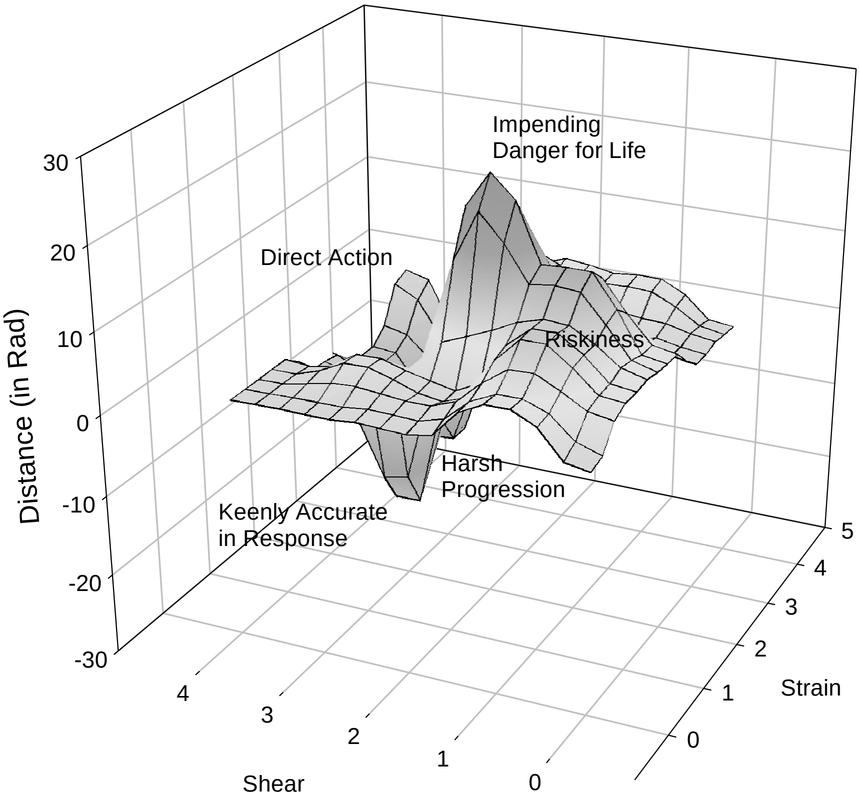


Figure 4.

Examination Text

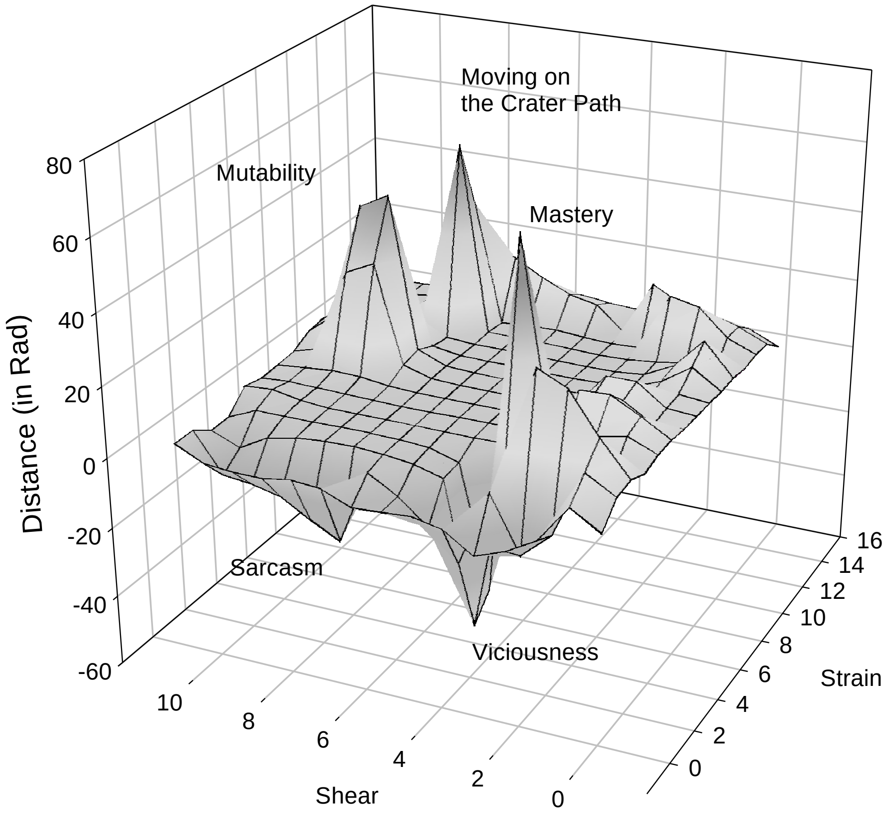


Figure 5.

Structural Similarity of Landscapes

	Depth	Height
Older	Harsh Progression Keenly Accurate in Response	Riskiness Direct Action Impending Danger for Life
Younger	Viciousness Sarcasm	Mastery Moving on the Crater Path Mutability

It should be pointed out at once that structural similarity should not be mixed up with its meaning in a semantic context. To be structurally alike in import, the termini have to be associated with the same area of the landscape or the same sphere. In a certain sense, they have in some respect to be either more concrete or more abstract in their orientation, compared to their control termini. The following comparison is therefore made pair-wise:

Riskiness – Mastery. The terminus of the older text implies a heightened perception of a predicament and what kind of consequences this state may have if one takes a non-planned step. The terminus "Riskiness" on the hillside is marking some kind of precaution. "Mastery", on the other hand, is determining a strong marking peak, which gives expression to an adventurous attitude in a hazardous situation. Before one has not been able to test one's power, it is difficult to know where the line has to be drawn between dangerous and safety situations. Sameness between these two termini is grounded in their complementary relationship.

Direct Action – Mutability. The first terminus, by means of its level headed expression, gives in the older text a sense of competence, when one has to react in the most adequate way towards something threatening. In the younger text the same sphere is marked with "Mutability", which implies a situation of unpredictable changeability. A state of this kind is very difficult to master. Here is the older text action oriented while the younger continues to be in a state of weighting.

Impending Danger for Life – Moving on the Crater Path. The first expression in the pair is without circumlocution the most definitive attractor description, which is related to conflict, i.e. war. Furthermore, an insight is emerging into what war is about. The second expression points toward what a soldier has to expect when going to war. However, balancing at the edge of the precipice may be experienced as an adventure, which one has to go through when growing up. The disparity in the pair may be likened with going to war on the one hand and do one's compulsory military service.

Harsh Progression – Viciousness. The terminus of the younger landscape is basically circumscribing the underlying anxiety of the bottomless pit, which makes war to a hell an turns one's feelings towards something that cannot be mastered in this infernal act of balancing. Meanwhile the other terminus in the pair is addressing some sort of survival instinct; to take command over the situation and to go ahead with the aid of rough means must be the goal. The older text gives also here an expression of insight of what is required if one wants to survive, while the younger text is staying at a feeling of discomfort.

Keenly Accurate in Response – Sarcasm. This pair gives expression to a mentally purified conduct, which must prevail in the described situation. While the younger is conceived of as a caustic form of expression as a way of relieving anxiety the older is concentrated on improving acuity of one's senses. From the functional point of view the latter is more powerful and consequently expresses the manifestation of a higher degree of maturity.

The three termini of the older text, describing Height together are expressing avoidance, while the termini, describing Depth stand for endurance, i.e., they imply maturity and calmness. This is precisely the information carried by the shape of the landscape. Corresponding termini of the younger text reflect trying out, associated with grim humour, which instead points to a mental landscape of lower degree of maturity. Hence, the attractors of this shape are the result of a higher degree of motion and below sea level is emerging a rather agonised feeling than resolute control. However, it is not difficult to see that both shapes give expression to structural affinity. The configuration of the student appears as a preliminary stage to full insight into the concept of War, completely in agreement with the expected outcome.

With respect to the examination of the understanding of the concept of War by means of a novel, in the student's structure are emerging such characteristics that can refer to a number of war novels of the 20th century. The high rising mountains in the landscape are carrying information that can easily be connected with realistic portrayals from both World Wars as well as with modernistic and psychological descriptions of the wars. Several of them have also been written in satiric style and a dark humour, which can be recognised through the areas below sea level. The student of the presented study has read Erich Maria Remarque's novel *At the West Front Nothing New* (from 1929). The anxiety, which lies embedded in the structure, may very well be considered as an expression of the basic idea of this novel. From a diagnostic point of view the test has been successful and produced a result that is promoting the student.

In sum, a student's ability to express his synthesis must be attached to the quality of the material and not to the quantity of materials. Of course, the teaching goal may be to have the student read a certain number of works, but the teacher must have a sound judgement and select strategically in order to circumvent an over-load of the student. Furthermore, it has now been possible to demonstrate that a student at a certain stage may not have been able to demonstrate his analytical abilities, but can nevertheless have the ability to find intuitively a solution to the task, i.e., demonstrate synthesis. A teacher may very well have experienced this many times, but cannot get it manifested. In the present case, the student was not motivated and needed some form of encouragement in order to continue his studies. In other cases this kind of results may be used diagnostically and provide the basis for the design of a study course that lead to the desired results. The elasticity of the clip is in both cases facilitating individualised processes of teaching.

Discussion

When the teaching methods are reconsidered today, it becomes also necessary to take a new look on knowledge examination. What has changed since 1968 is not the definition of knowledge but its evaluation. The apprehension of analytic and linear forms of knowledge is the necessary basis in order to be able to penetrate factual phenomena. This kind of knowledge is low valued when teaching is planned and realised in the form of projects, in which large knowledge domains have to be comprehended. In this context holistic thinking is higher valued, however, without knowing its shape. It is even lesser known, how it can be built up and examined. Therefore, one can observe a great confusion about the concepts of analysis and synthesis. Neither educators nor psychologists can provide instruments for testing synthesis. Independent of the attempts to introduce modern holistic thinking on all levels, the students' knowledge gain is nevertheless tested with analytical methods and instruments. A contributing source is one's ability to make inferences and draw conclusions. This ability is the cornerstone in many subjects and when transformed into test items, it is confused with the student's synthesising ability. Obviously, a conclusion is nothing else than summing up the analysis. A summary is not the same thing as a transformation.

To construct a school, instruction and testing system on the student's interest appears at a first look as an attractive and possible alternative, at least against the background of Abel's (2001) studies and discussion. The choice of a study program at the Gymnasium level is very often manifesting an orientation in interest. Therefore, the latter, should provide a supporting function for the student's possibility to be successful in his study. However, the classes, studied in the present context, do not support the hypothesis that the student's interest guarantees satisfactory test results. Through the comparison of linear with criterion related tests, it could be demonstrated that the results could be steered into the desired direction. Thus, the student's choice of study program appears to be of subordinated import. Concerning their pretension of passing a certain degree of difficulty, the students of the Natural Science program as well as the students of the Business Administration program judged themselves to pass the exam at an unrealistically high level, compared to their factual performance. Also here appears the orientation of the study program to be of subordinate import for the achieved results. Rather, what has been decisive, was their inclination towards enterprising and willingness to take risks, to manipulate with playing and do laboratory work. This kind of interest, however, lies on another level than what is covered with the courses of a study program.

The exam of concept understanding made evident that the students from the different programs did perform equally strong or were equally weak in demonstrating their ability to transformations. Evidently, there are no clues that something other than linear learning strategies had been at work. Hence, what was missing is a synthesis based learning strategy. Synthesis is the constitutive of the concept of structure. But to measure synthesis must be connected unconditionally with text production. In the testing of concept understanding, clear indication appeared that pointed towards an application of one's synthesising ability, but on what kind of structure the synthesis rested could not be figured out, because it was not tested. Moreover, the entire teaching process did cumulate with the testing of concept understanding, but the test showed that the study results are founded on other grounds than interest orientation as indicated through one's choice of program. Otherwise, at least one of the classes should have been superior compared to the others. For example, it would be expected that the Social Science program with its orientation towards society as presented in the form of novels would perform better on corresponding concepts. The students of Fine Arts, because of their general cultural interests would likewise be expected to perform better when tested on the cultural "ism". Finally, the students of the Natural Science program should do better on the concepts that have relevance for the scientific model presented during the course. Neither of the studied orientations produced noticeable differences. On the contrary, the test, which was designed to examine the student's structure, was successful.

Structure is something, which a student is building up by means of a program that is adapting the student to a subject, a material or a context (I. Bierschenk, 2001b). Teaching, which is aimed at providing the possibility for performing results as good as possible by as many students as possible, must be built on the possibility to catch the shades in their sensibility to the materials. The present school, instruction and judgement systems would with this kind of orientation evade the problem of building on the interest of the students. As Abel (2001) is discussing the concept "interest", the approach remains a matter of content, which is a surface phenomenon. And taking care of deeper lying life interests appears to be a difficult problem to manage and discipline. The synthesis-based examination of a student has pointed towards another possibility of approach and to get control over a structure, which can make explicit the kind of quality that the student must reach. Comparing the student's structure with the control structure made the attainment of the desired level evident for both student and teacher. With this result as starting point, the teaching and learning process can advance further and the student can reach even higher levels.

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